High Lift Prediction Workshop Results

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- CFD code used + solver parameters
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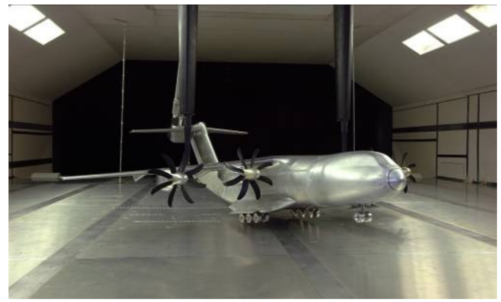
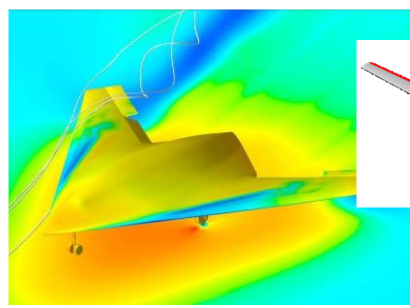
Introduction – RUAG Aviation – Aerodynamics Center

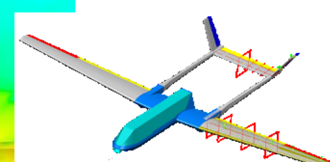
- **Wind Tunnel Tests Aviation- and Automotive Industry**

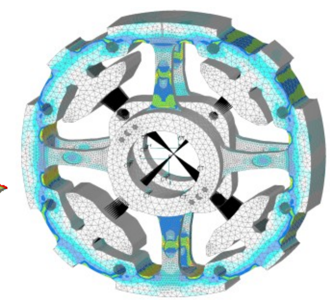


- **Instrumentation / Model D&M**

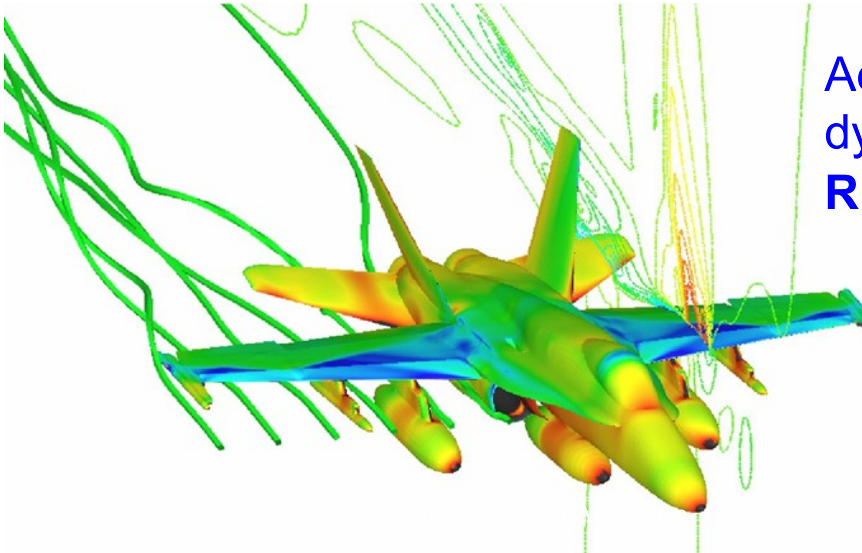
- **CFD & Flight Physics Engineering**



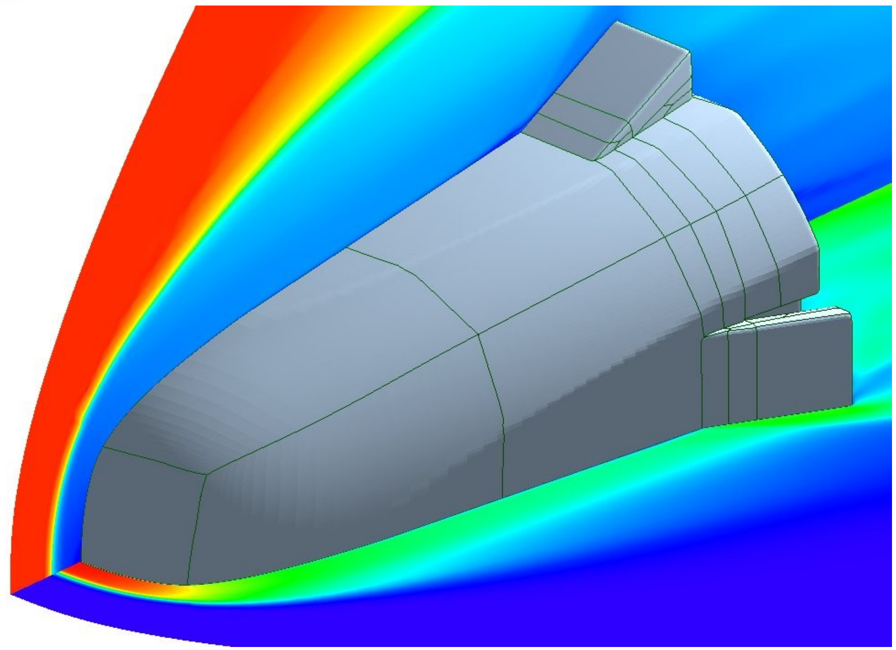




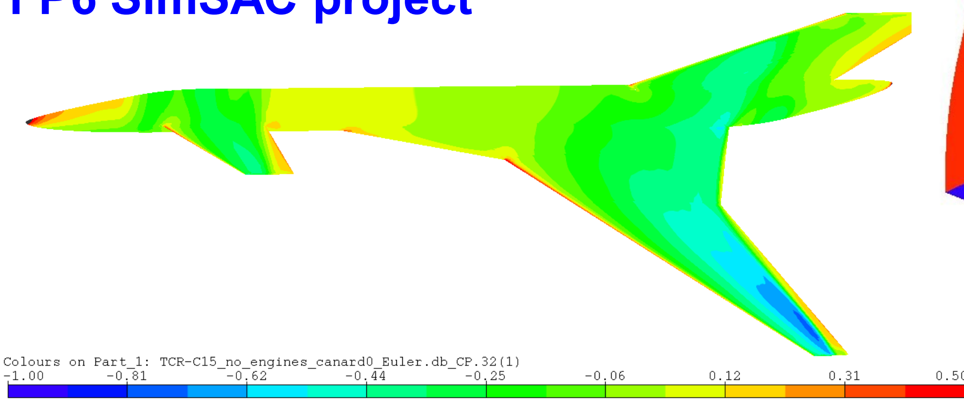
Introduction – CFS Engineering



Aerodynamic analysis of the F/A-18 including dynamic Fluid Structure Interaction
RUAG Aviation



Transonic Cruiser
FP6 SimSAC project



EXPERimental Re-Entry Test bed
European Space Agency

Introduction – why do we participate?

- To obtain a better understanding of the physics of high-lift flows
- To better understand the difficulties in simulating high lift flows
- To test our CFD code for this application
- Good experience from DPW4 workshop

CFD code used - NSMB

NSMB is a CFD code using multi block structured grids

Developed since 1992 in an international consortium with various industrial partners (Airbus & SAAB Military Aircraft until 2003, RUAG Aviation, Astrium Space Technologies, CFS Engineering) and academic partners in France, Germany and Switzerland.

NSMB includes all features you can expect from a modern CFD code in terms of grid flexibility, space discretization schemes, time integration and convergence acceleration methods, parallel computing capabilities etc.

NSMB parameter settings

All calculations were made using the following parameters

Space discretization: 4th order central scheme with artificial dissipation
Time integration: LU-SGS, CFL increased from 0.1 to 1.e12
Turbulence model: k-ω Menter Shear Stress (2 calculations using Spalart)

Convergence judged by residuals, convergence of aerodynamic coefficients and comparisons of solutions.

Grids used (1)

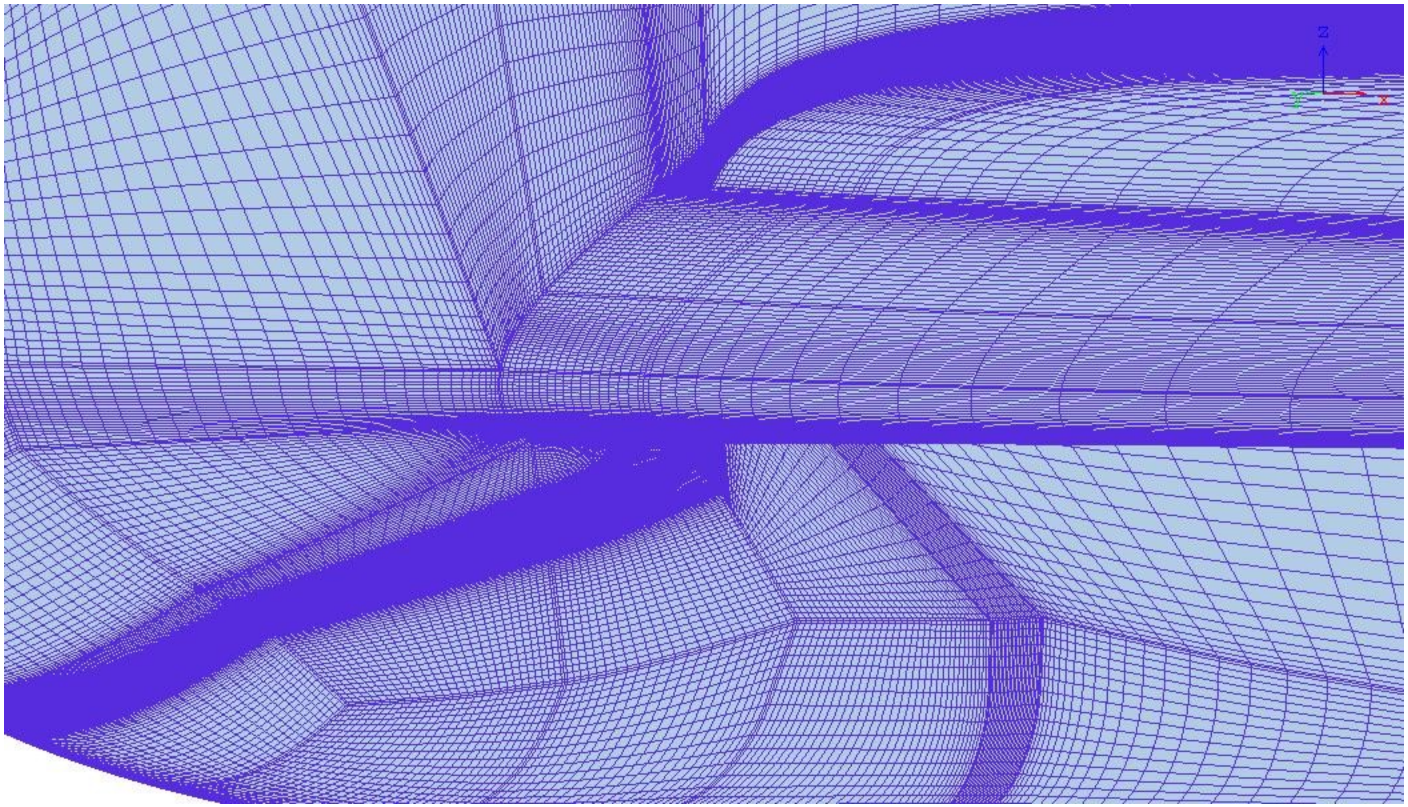
	Coarse		Medium		Fine	
	# vol (M)	# surf(k)	# vol (M)	# surf(k)	# vol (M)	# surf(k)
gridA	2.51	43.0	20.11	159.1		
gridC	6.14	126.0	11.16	190.0	41.44	428.4
cfse-ra	5.99	49.2	19.96	184.9	47.90	379.5

Polars computed only on medium cfse-ra grid

gridA and gridC were used for configuration 1, alpha=13 + 28

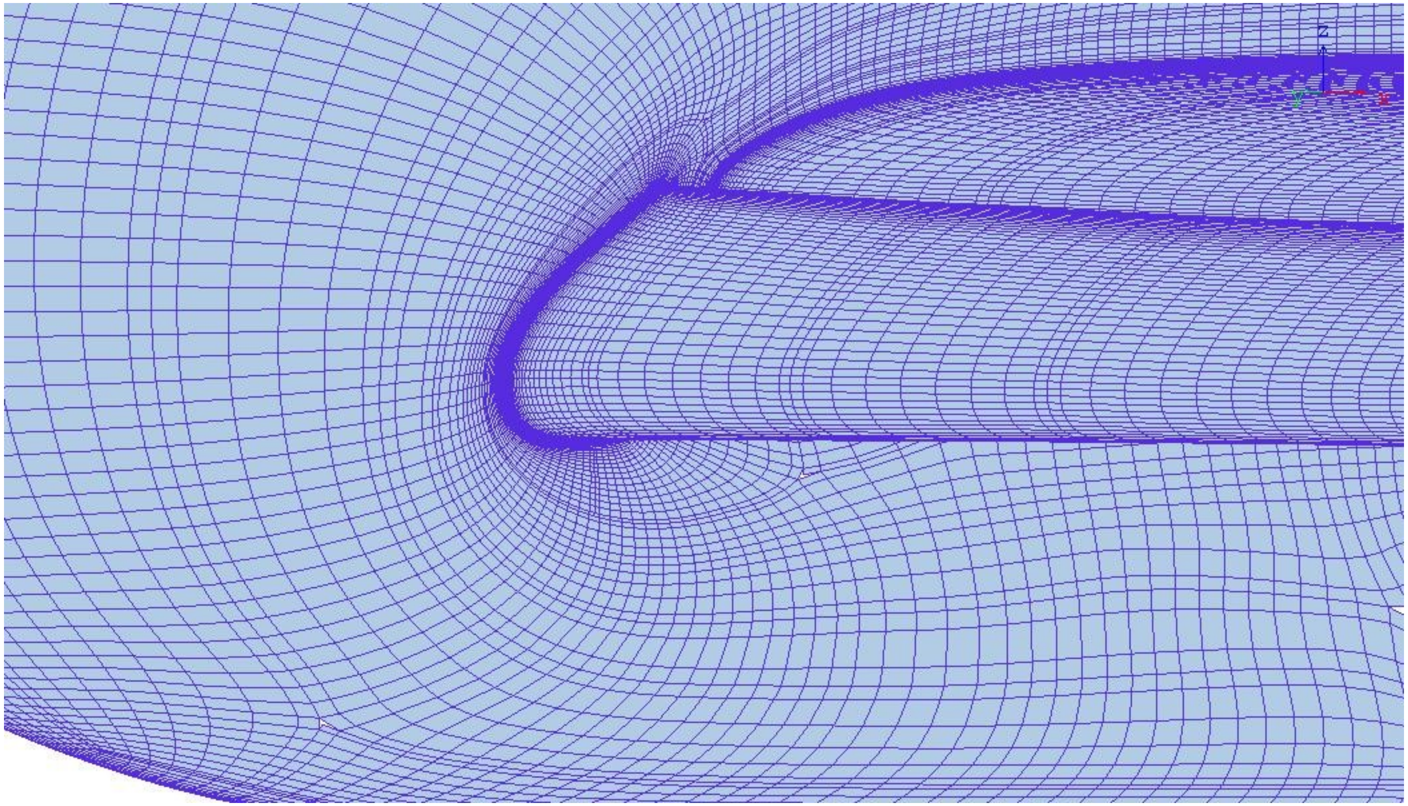
Not possible to make a calculation on fine gridC

Grids used (2) – medium gridA

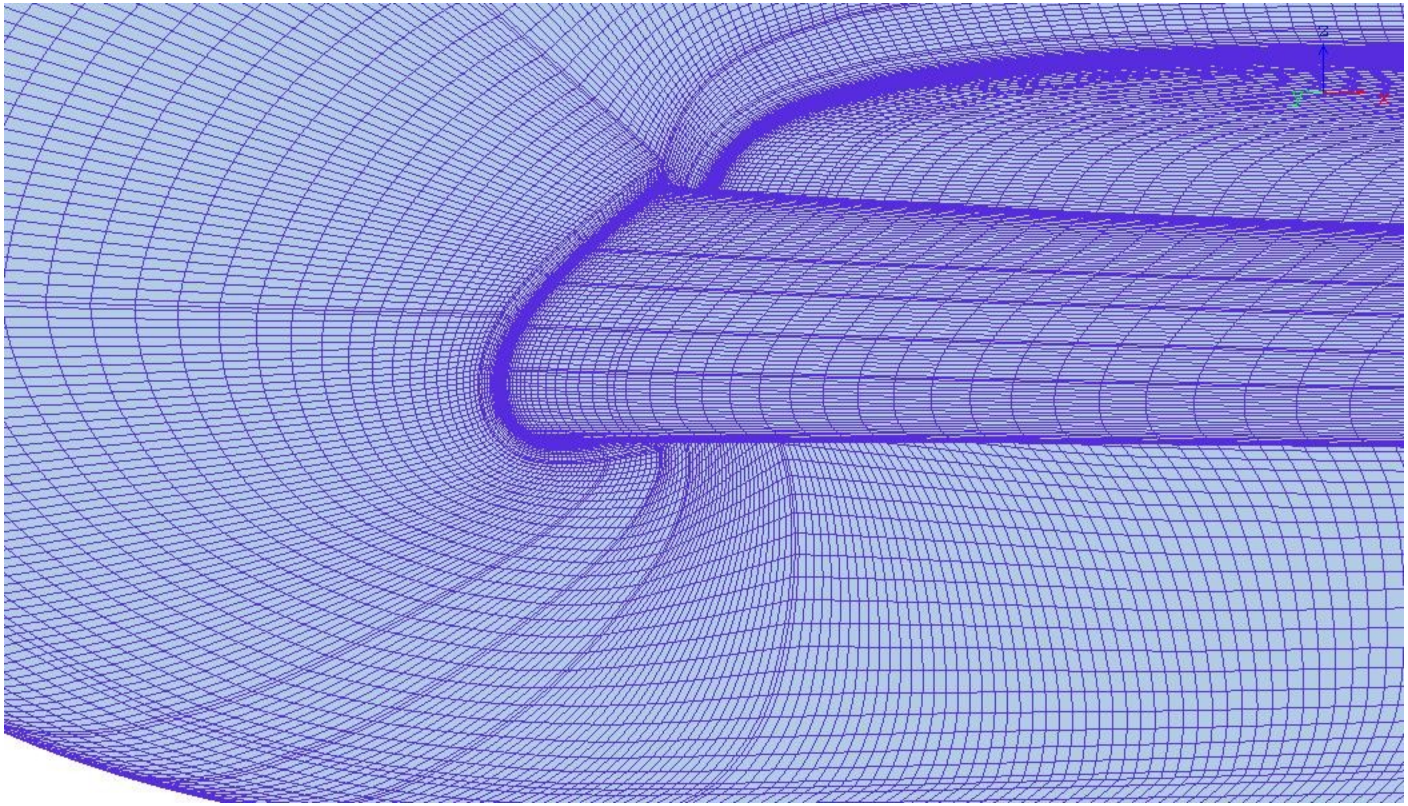


Boundary layer captured on slat via O-grid around slat + fuselage

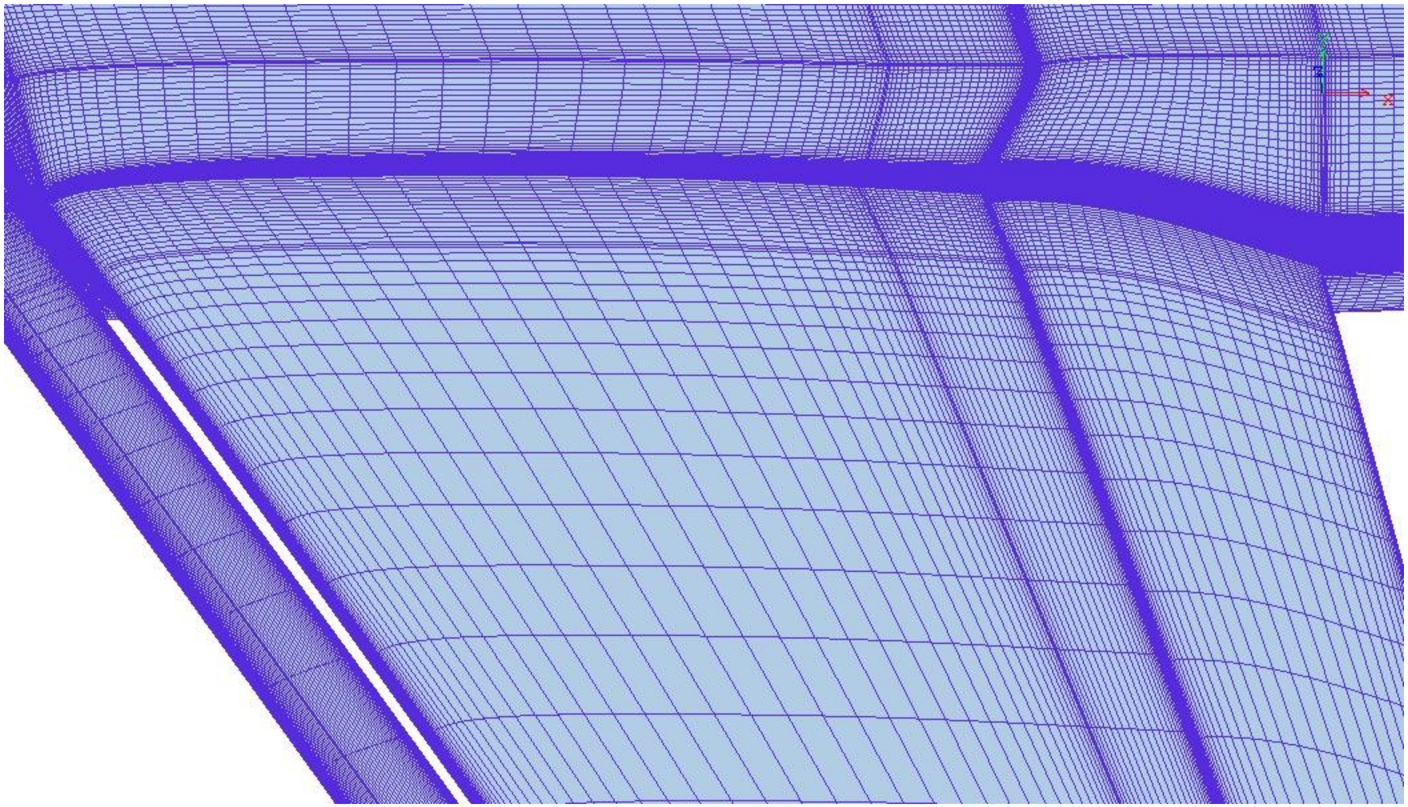
Grids used (3) – medium gridC



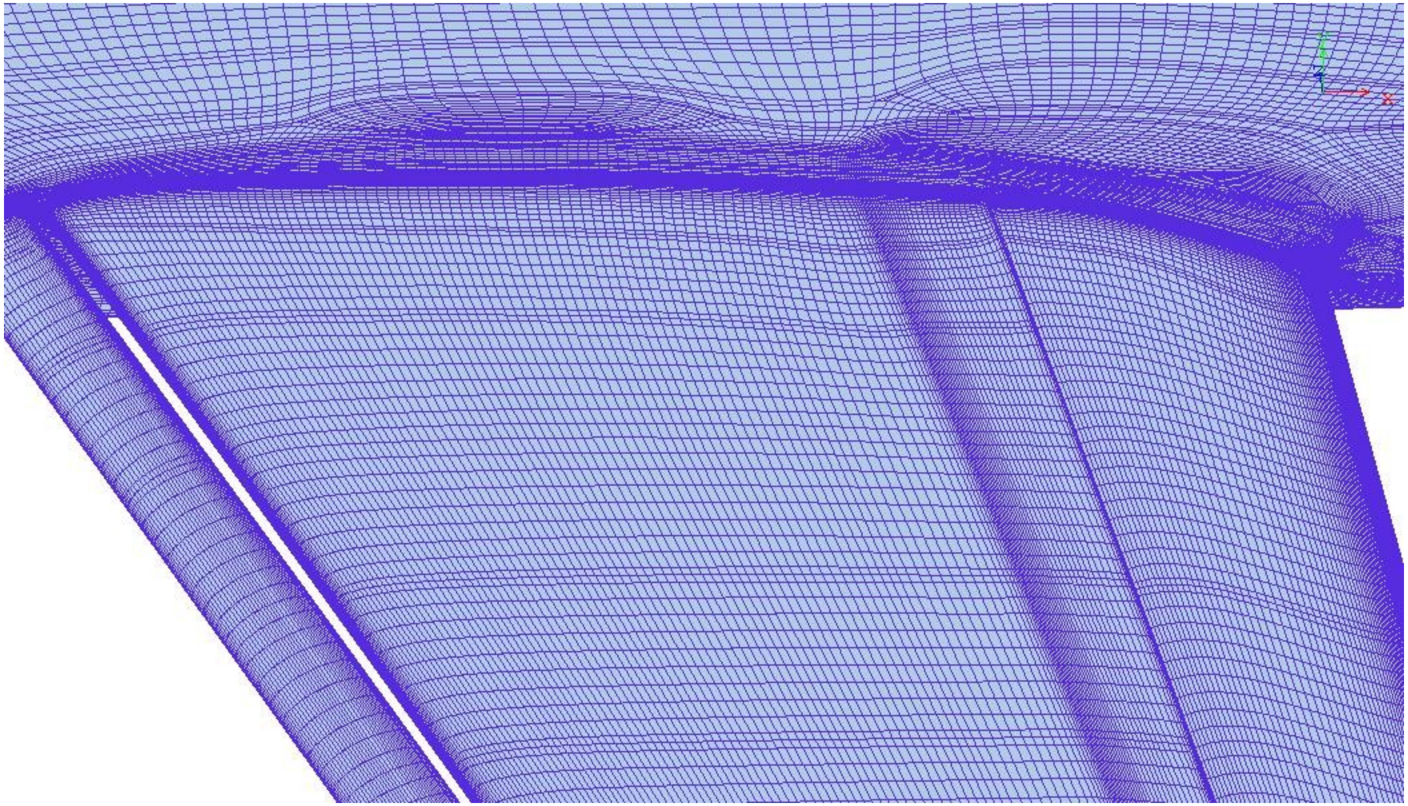
Grids used (4) – medium cfse-ra grid



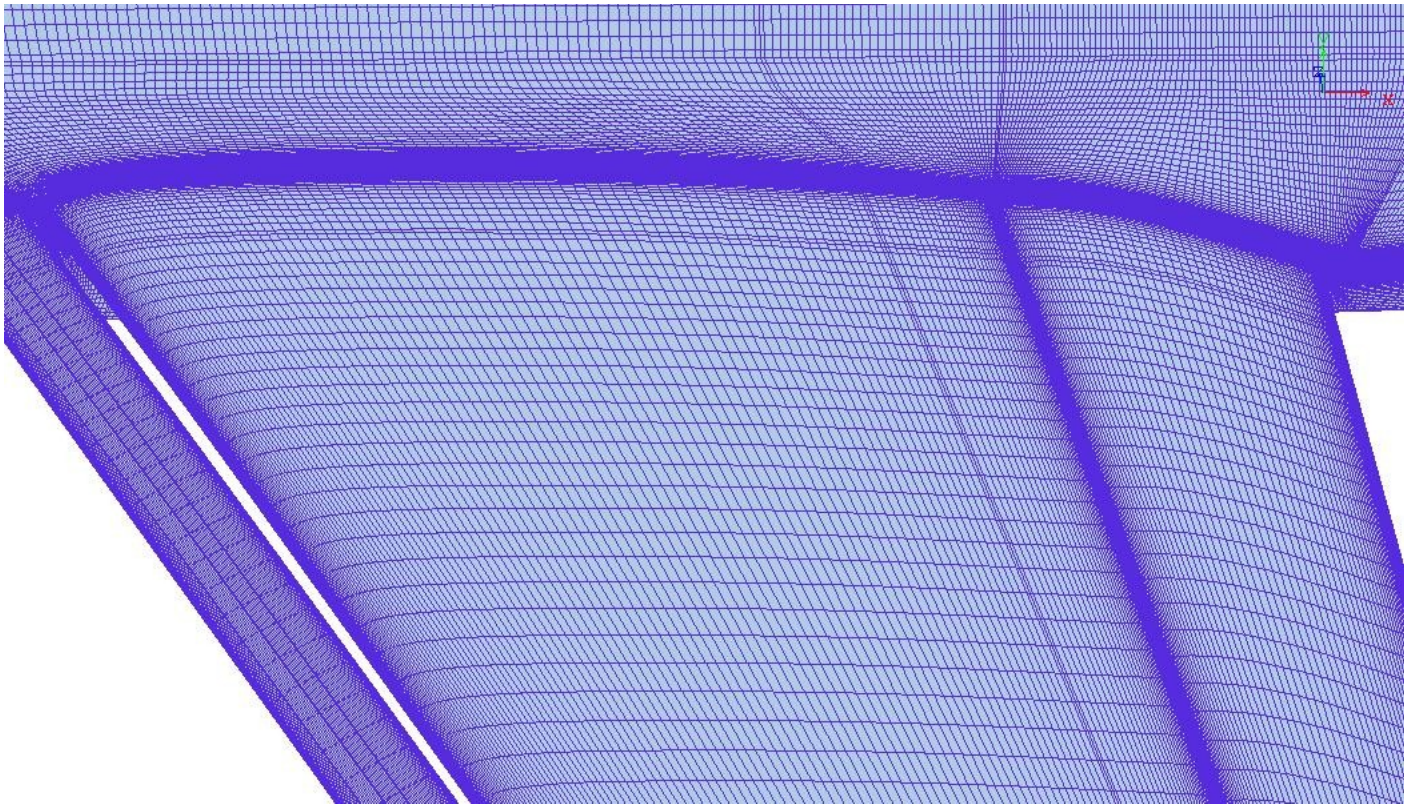
Grids used (5) – medium gridA



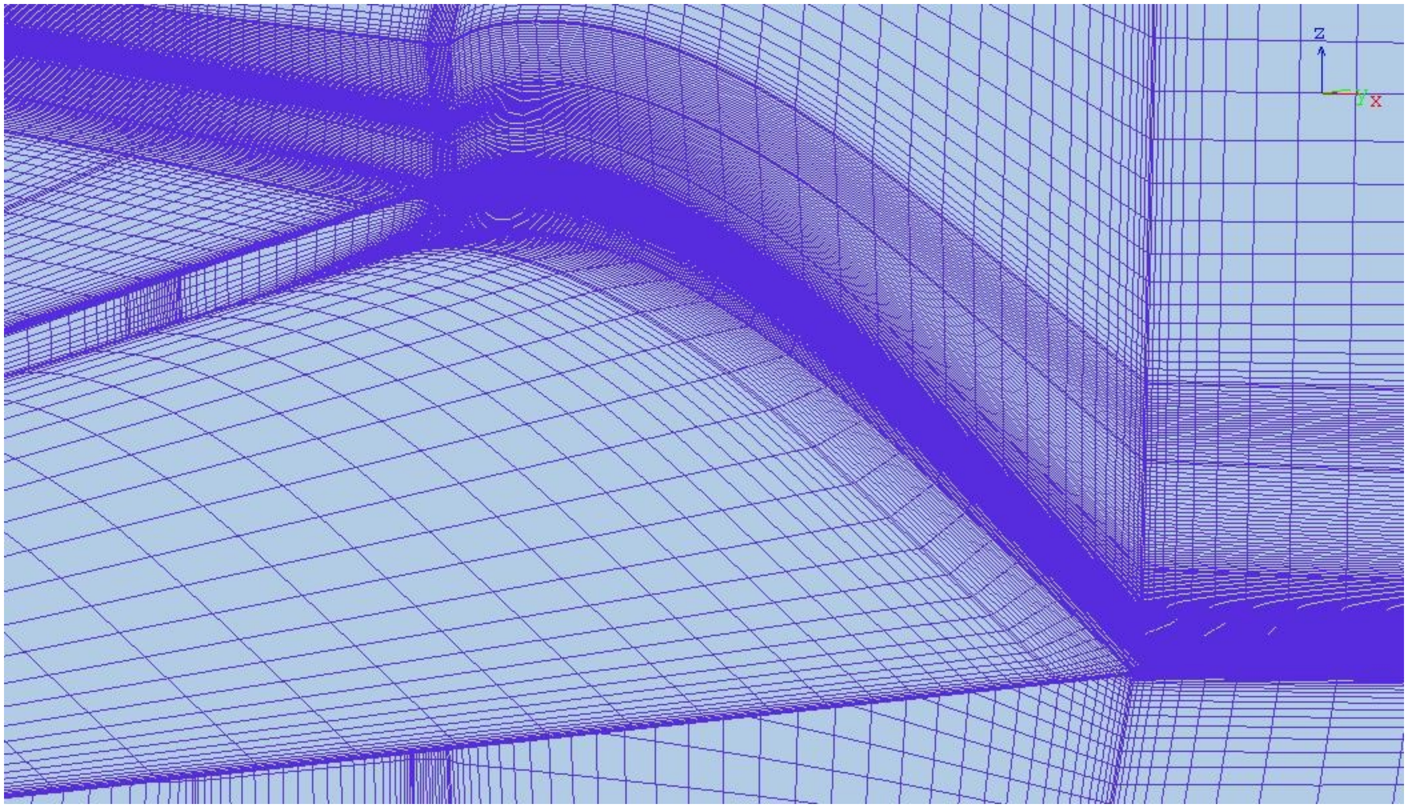
Grids used (6) – medium gridC



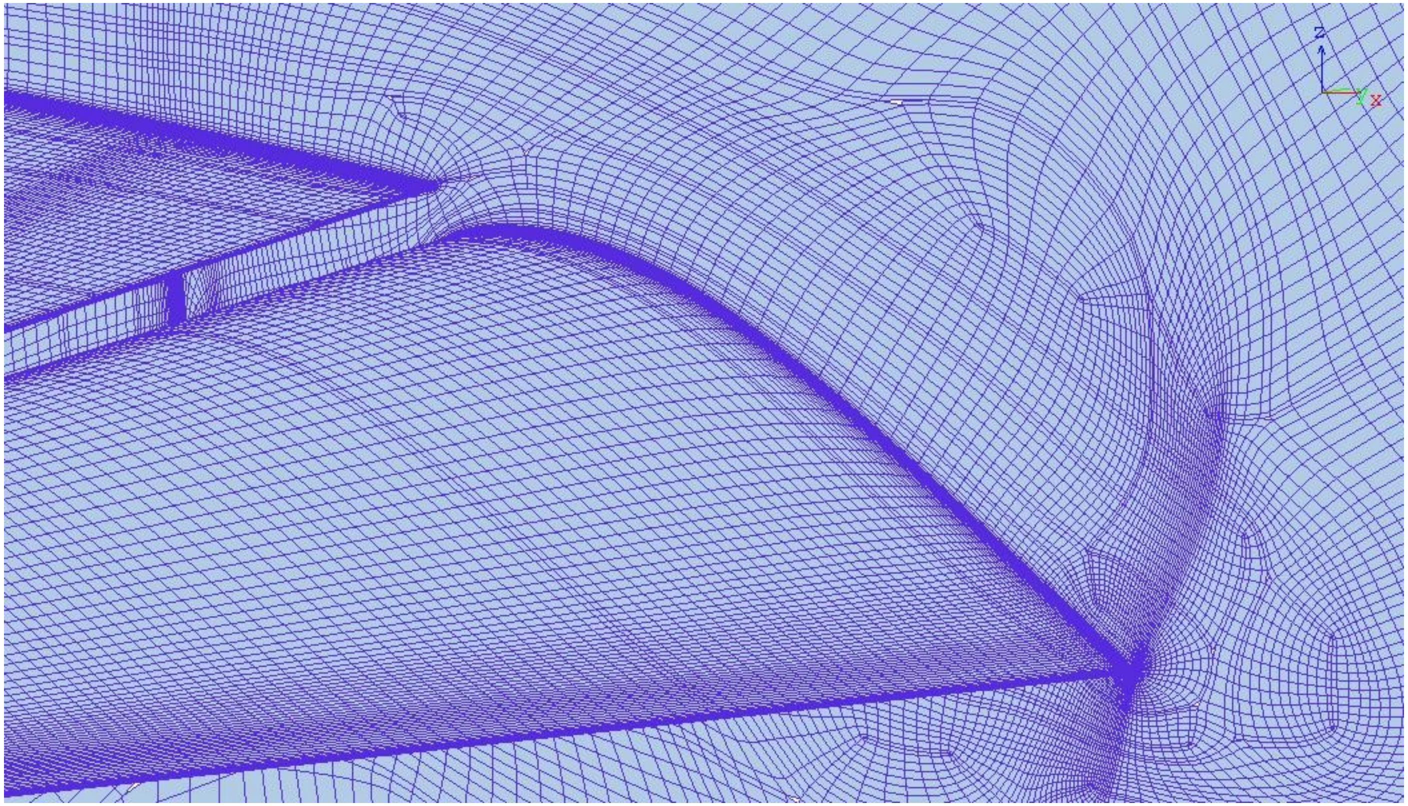
Grids used (7) – medium cfse-ra grid



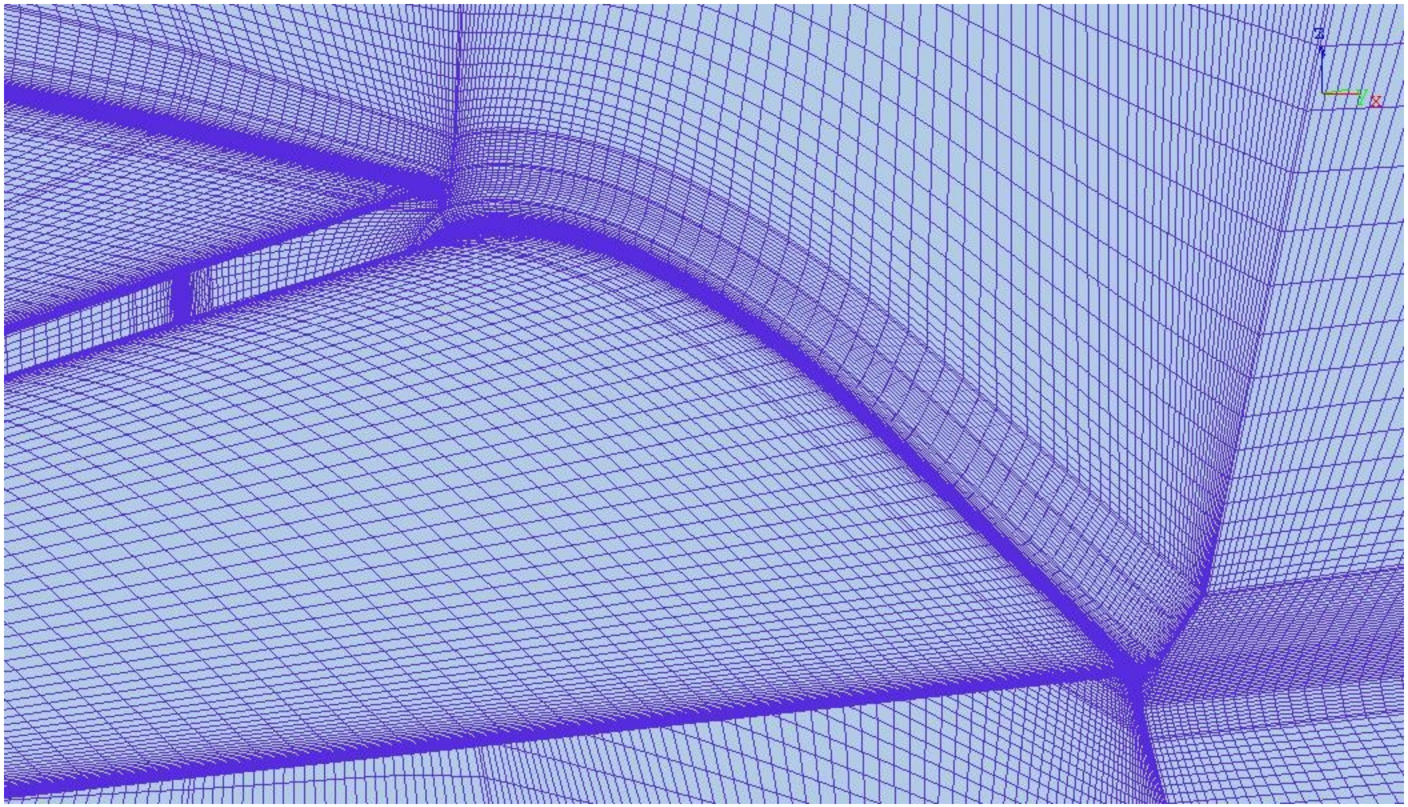
Grids used (8) – medium gridA



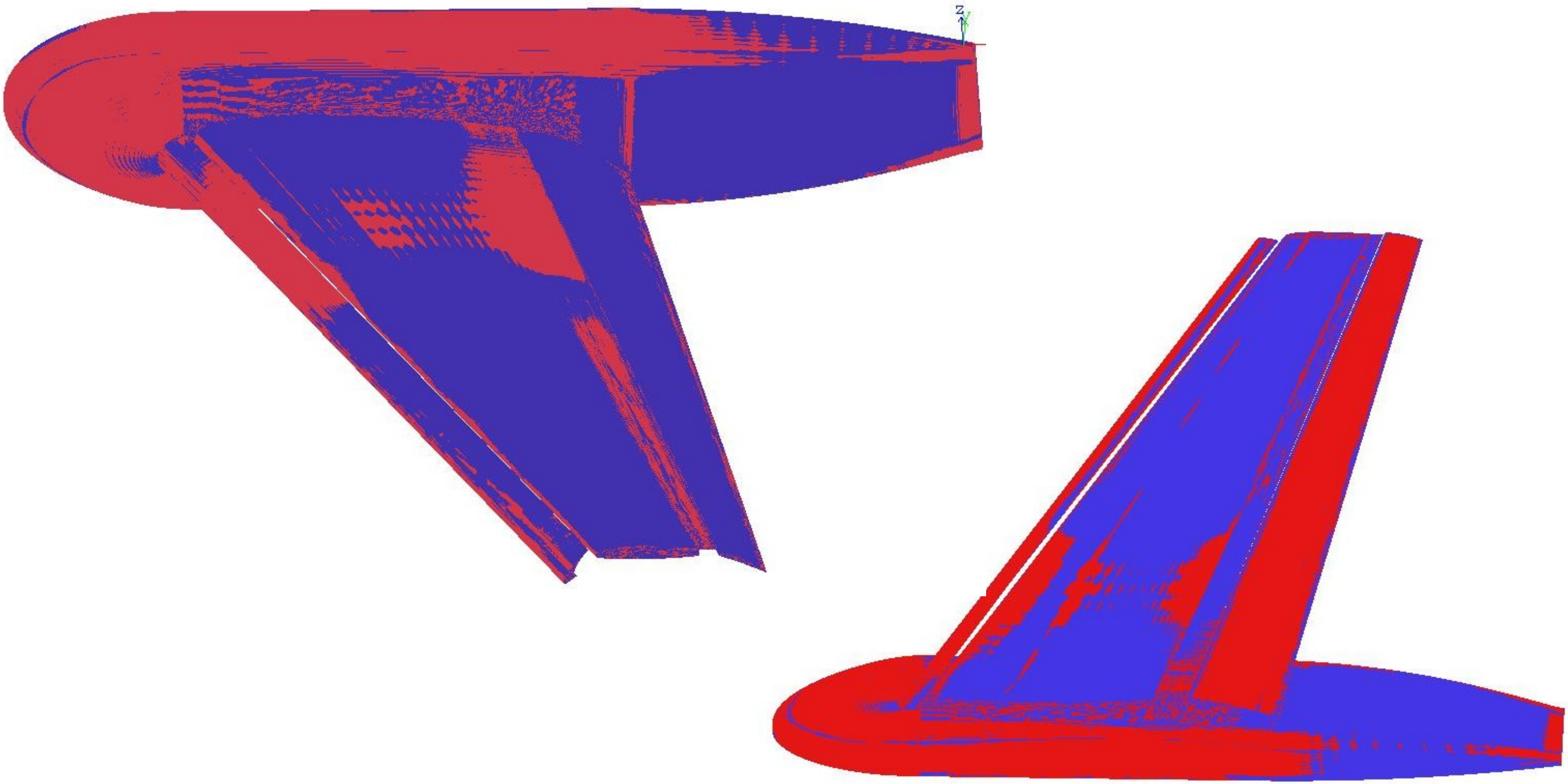
Grids used (9) – medium gridC



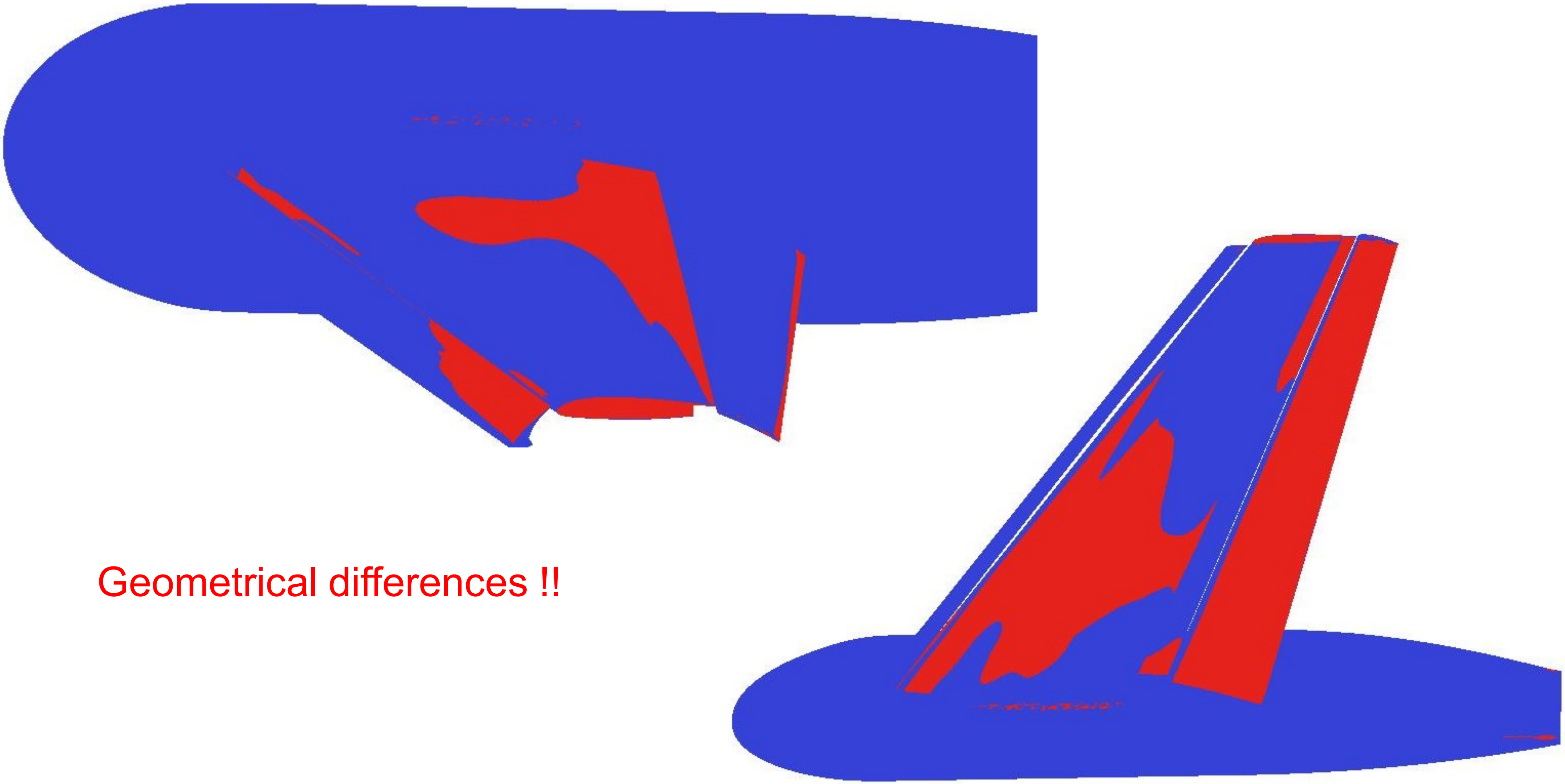
Grids used (10) – medium cfse-ra grid



Grids used (11) – gridA-cfse-ra grid

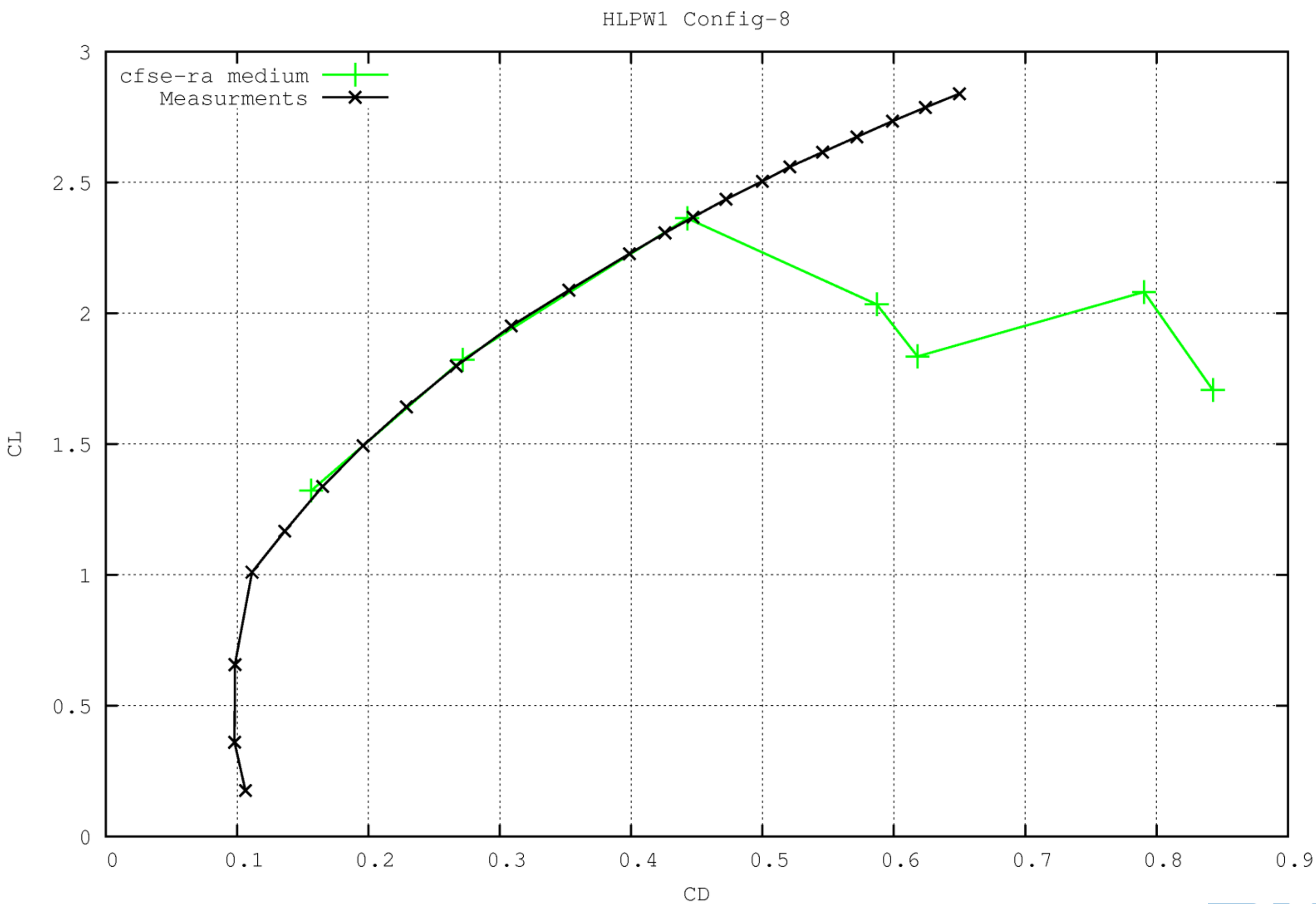


Grids used (12) – gridC-cfse-ra grid

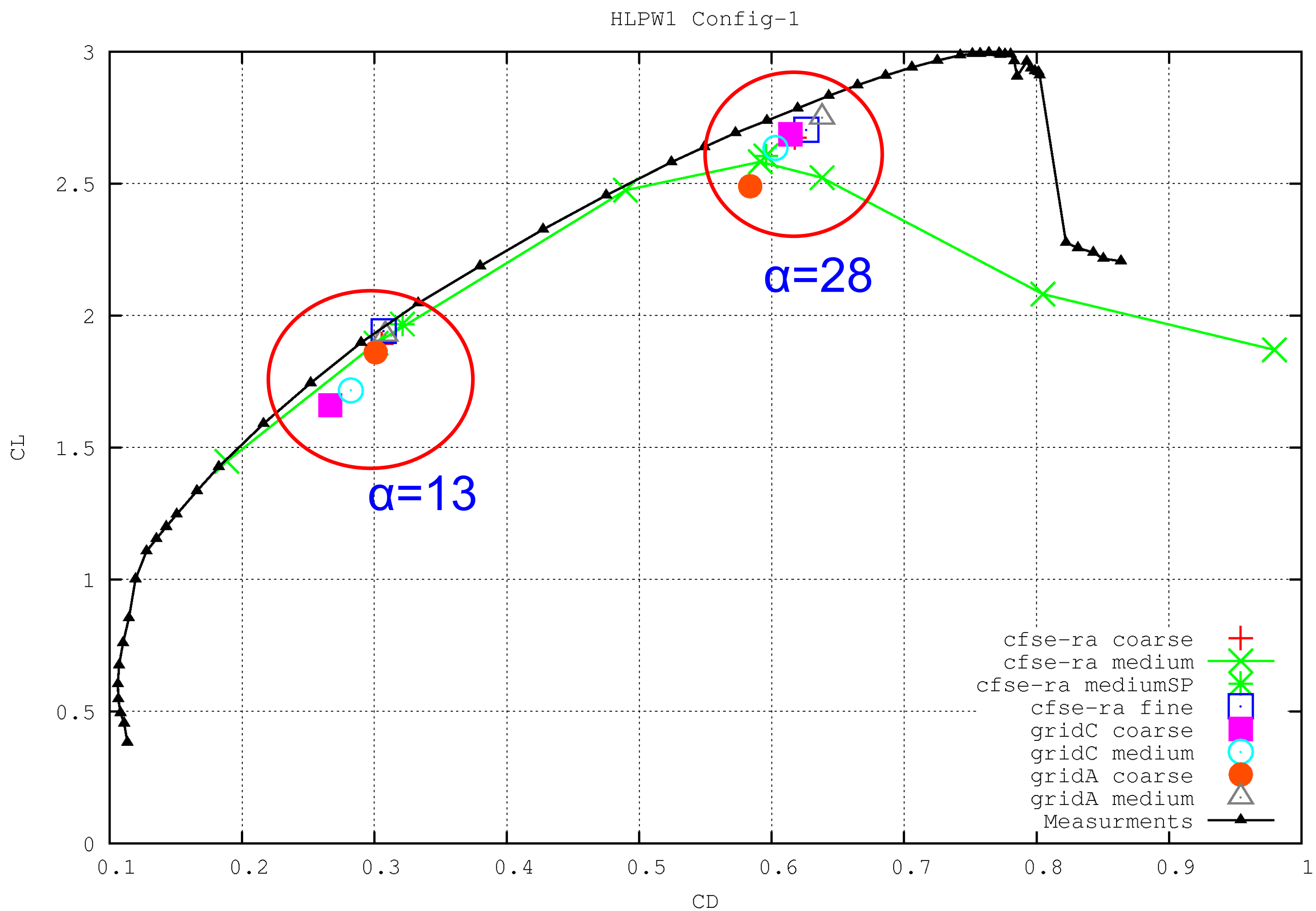


Geometrical differences !!

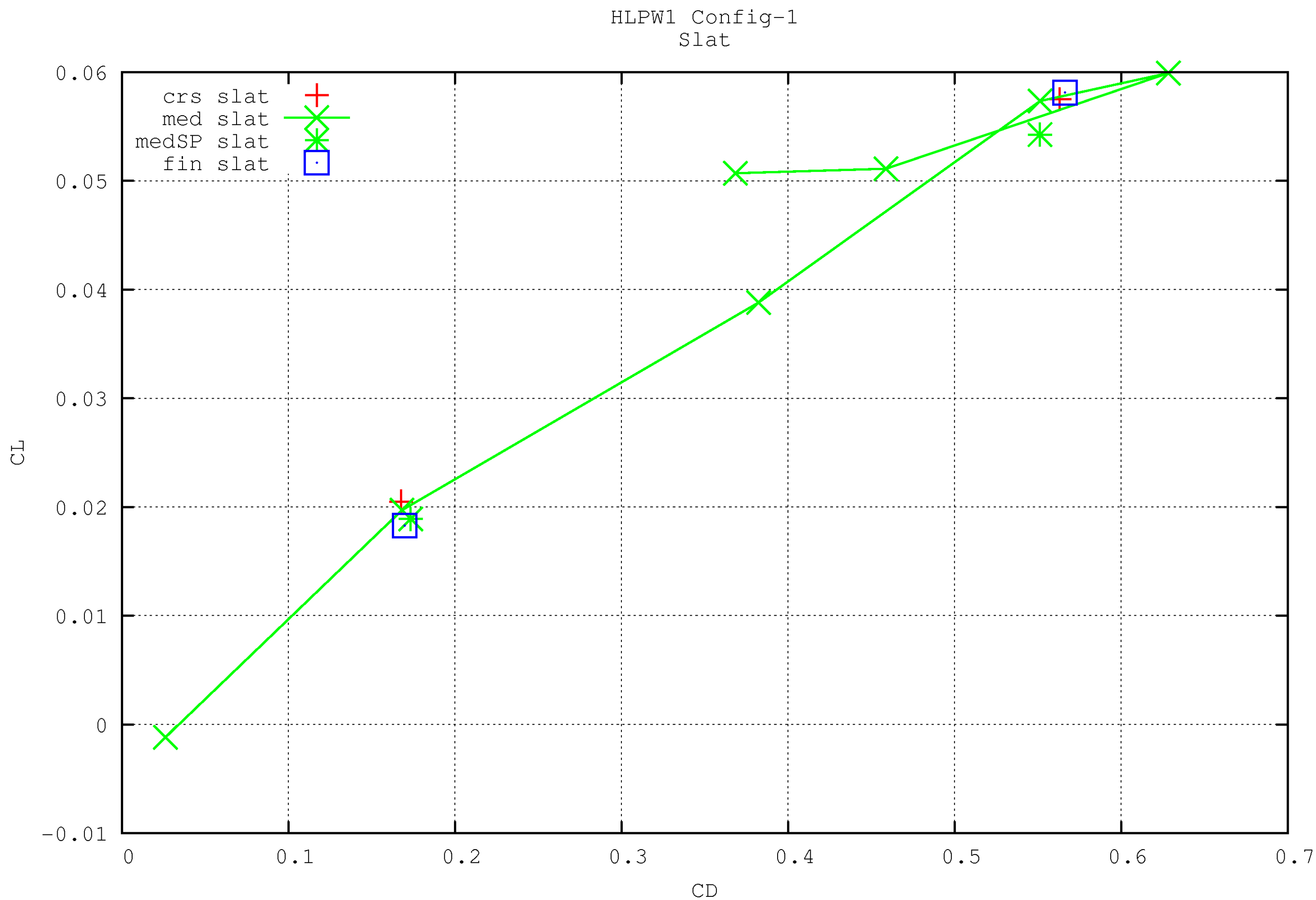
Results – Polar Config8



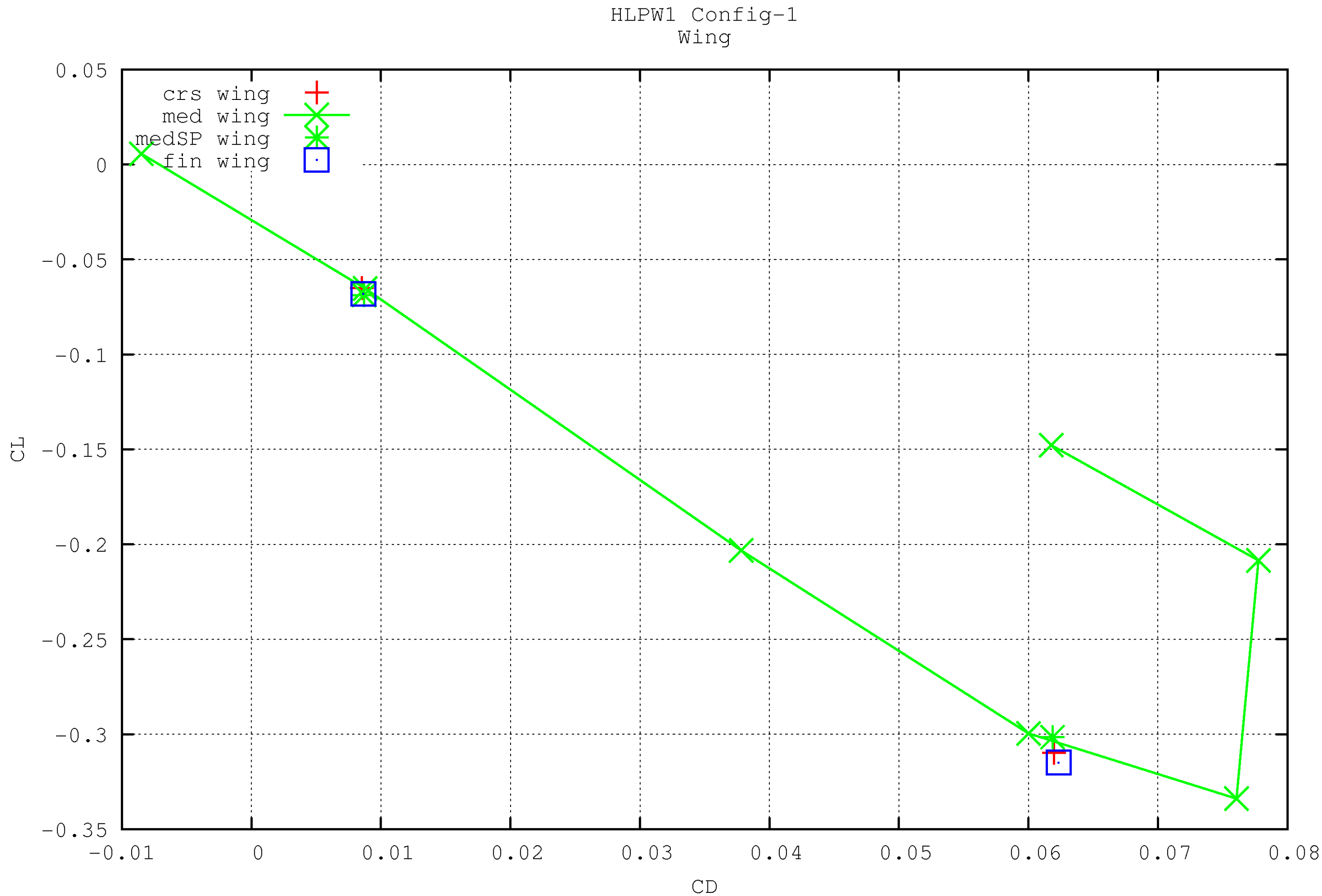
Results – Polar Config1 – all results



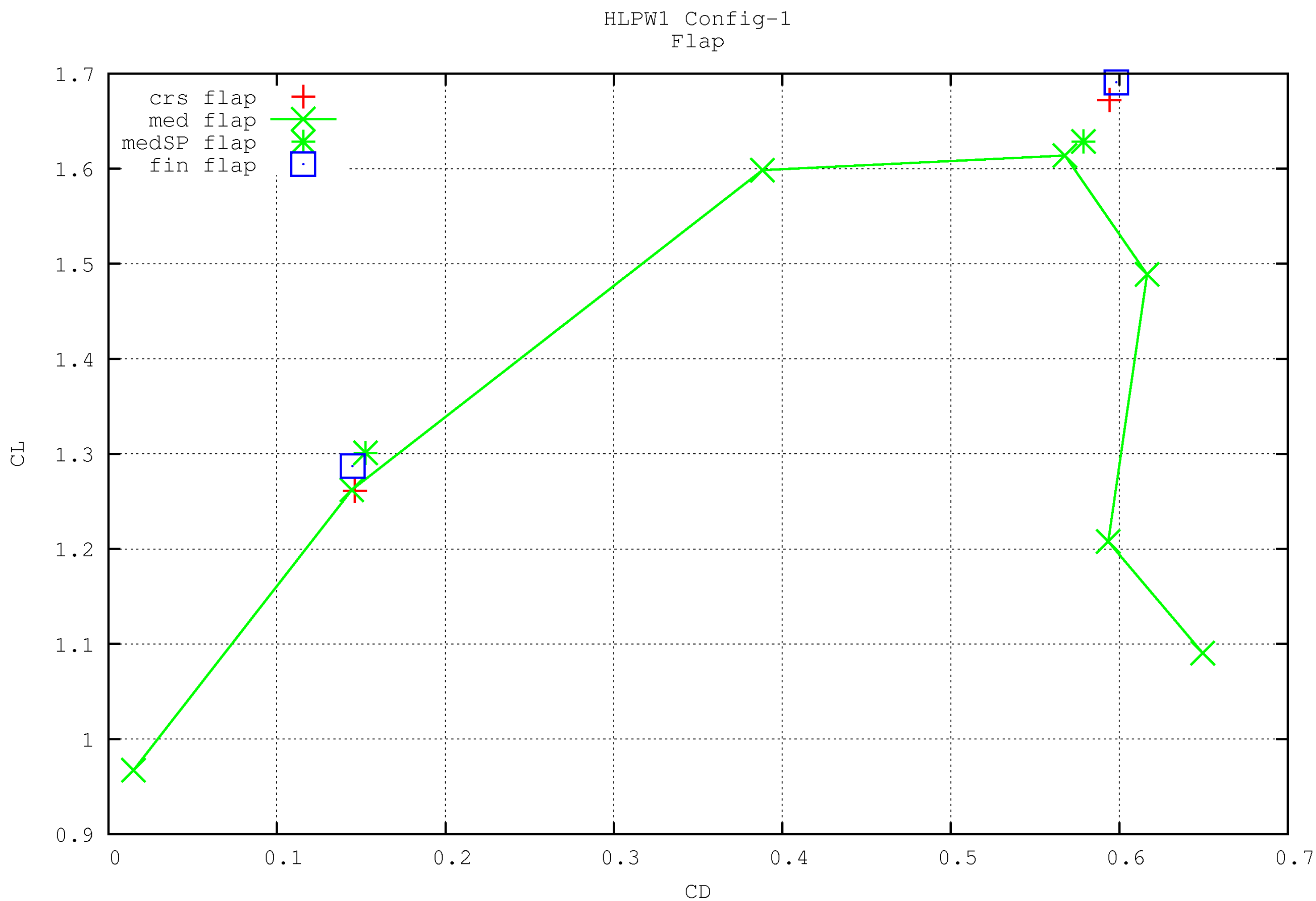
Results – Polar Config1 – Slat contribution



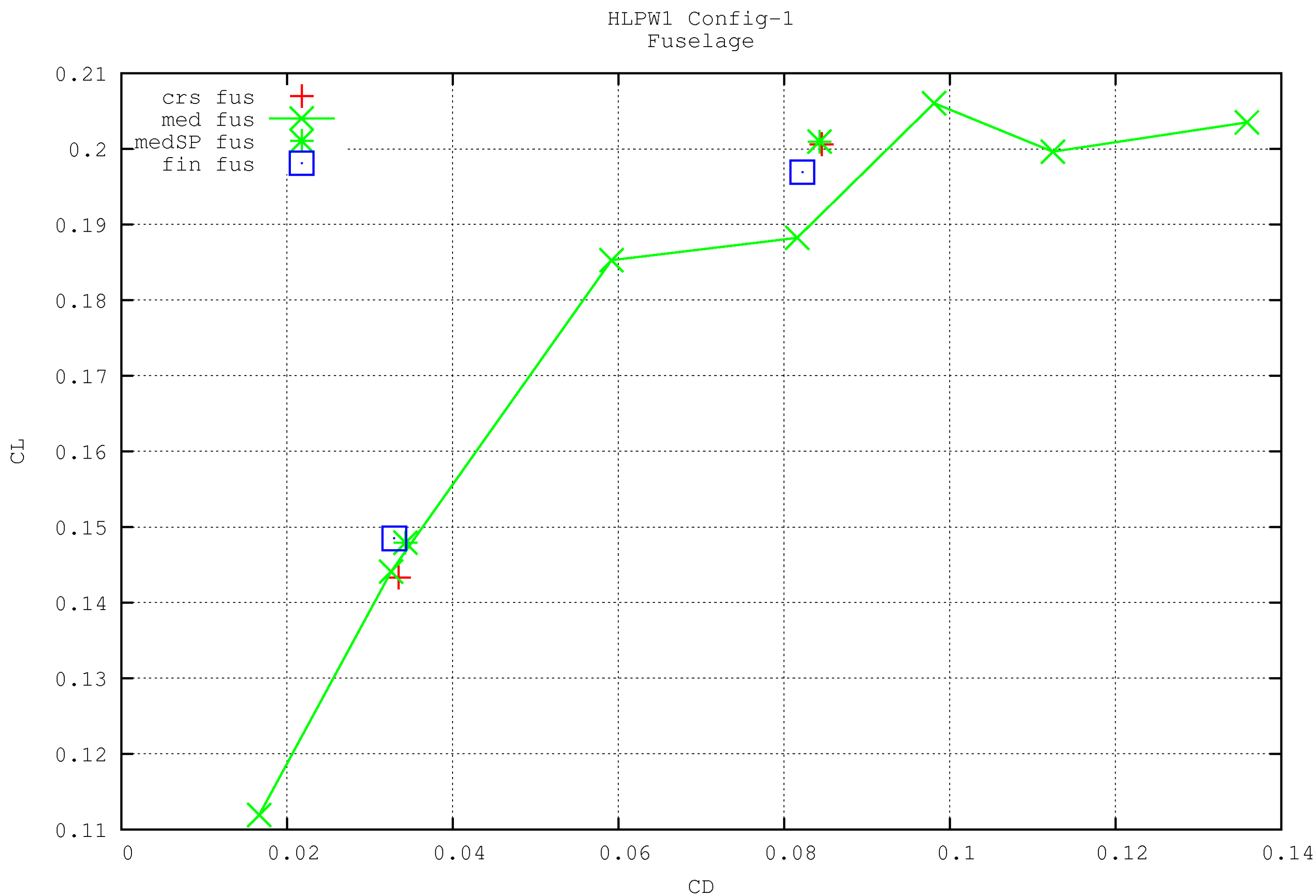
Results – Polar Config1 – wing contribution



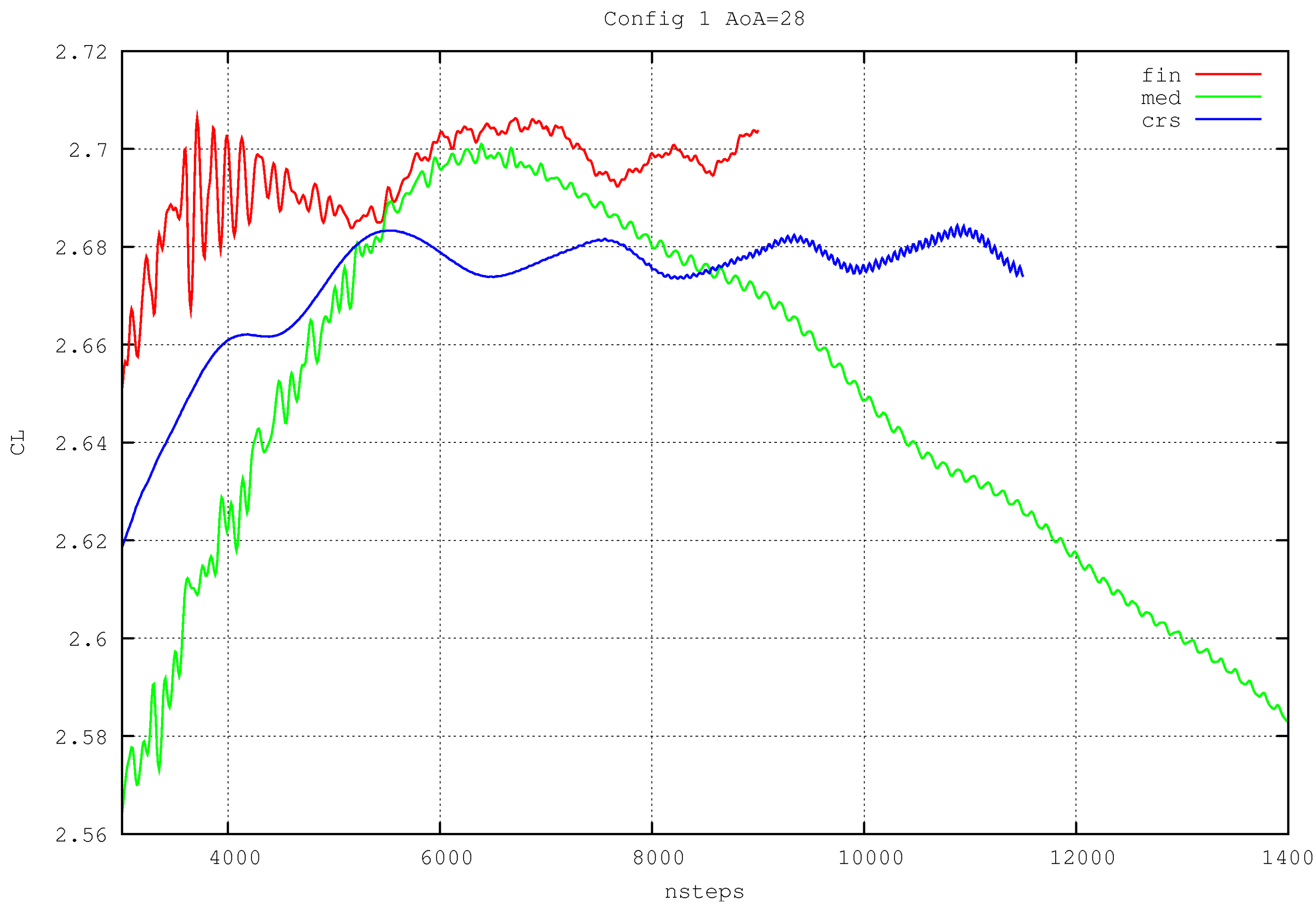
Results – Polar Config1 – flap contribution



Results – Polar Config1 – fuselage contribution

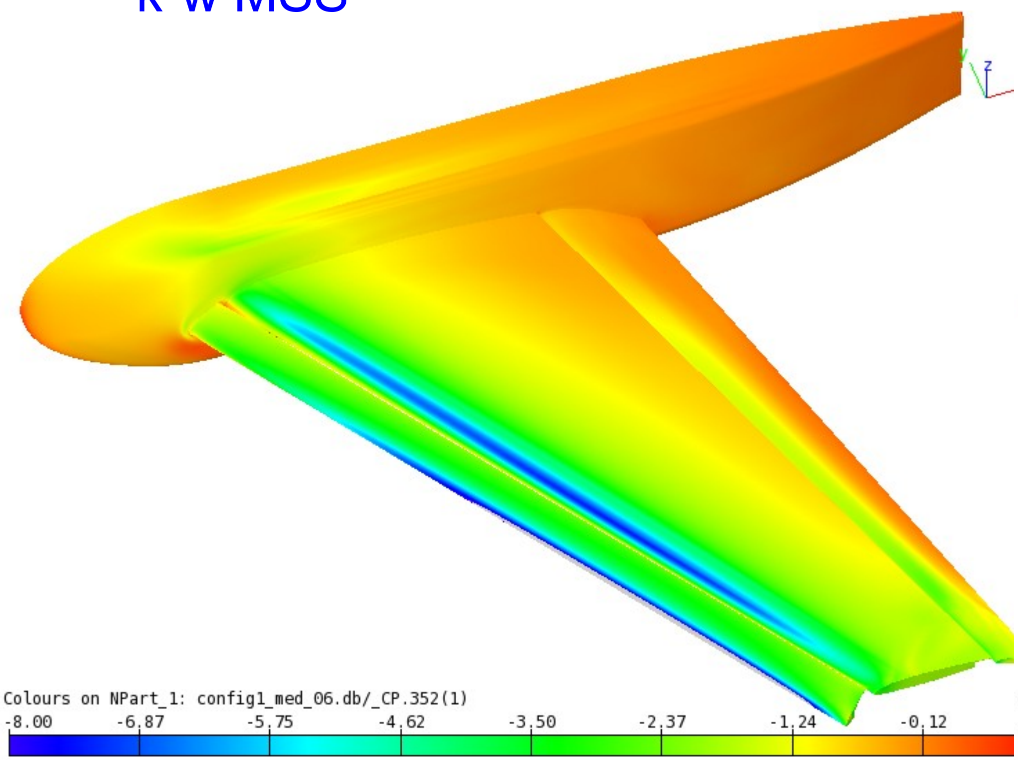


Results – Config1 forces history α=28

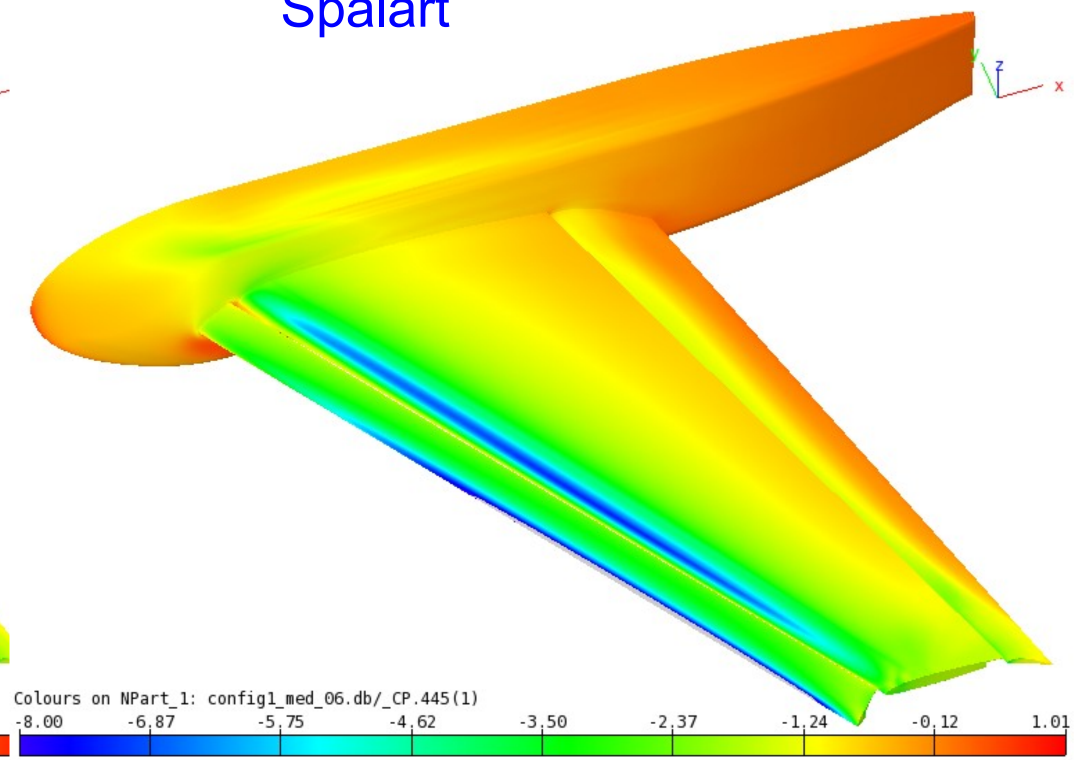


Results – α=28 Cp k-w MSS vs Spalart

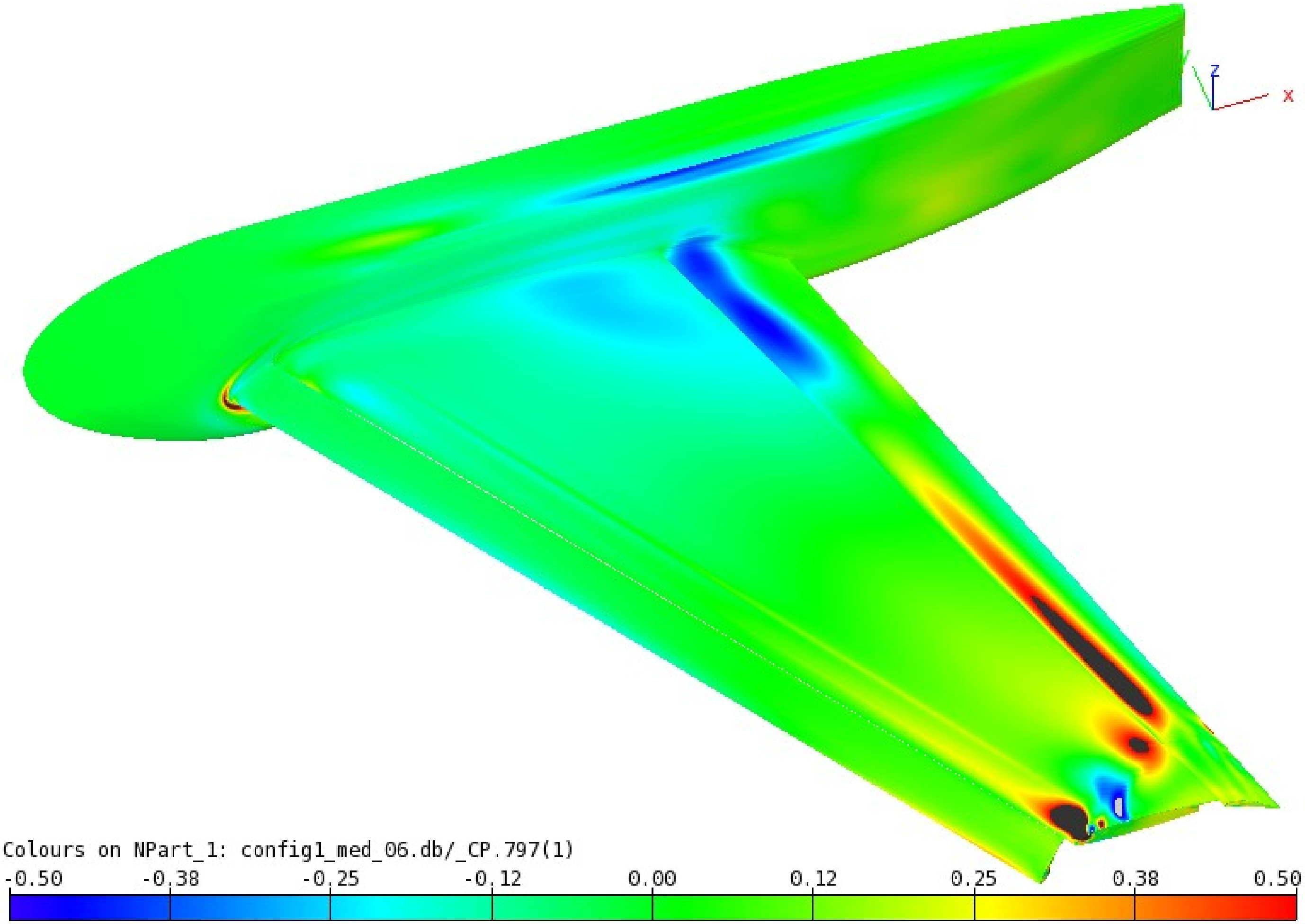
k-w MSS



Spalart



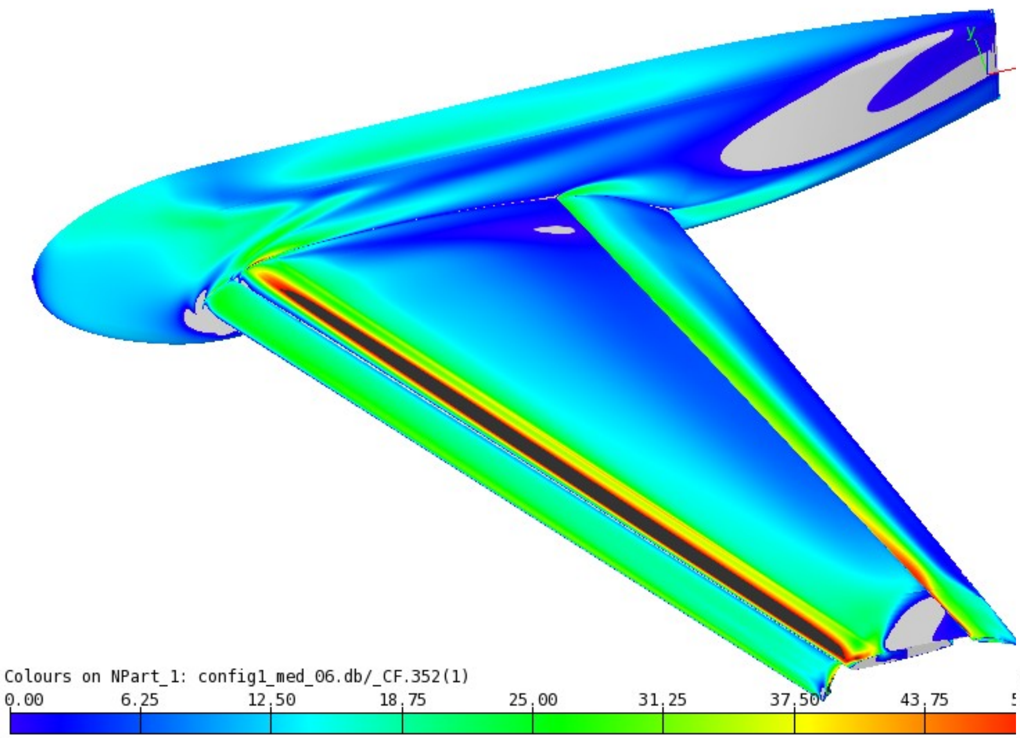
Results – α=28 - Cp Spalart – Cp k w MSS

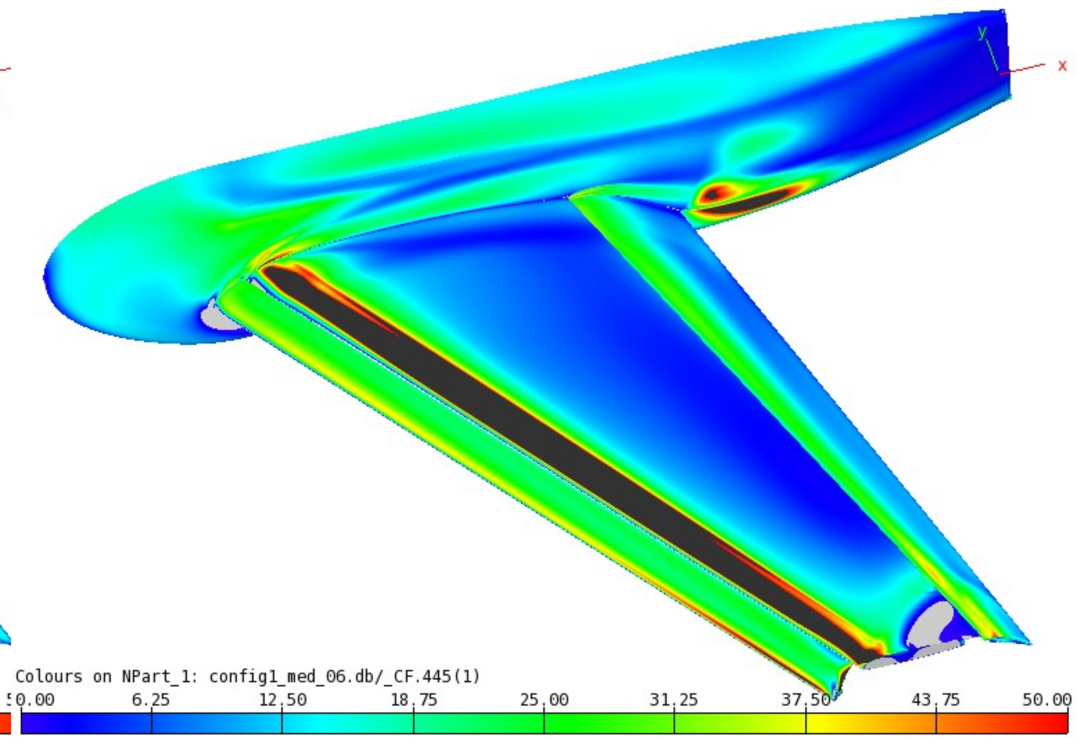


Results – α=28 CFx k-w MSS vs Spalart

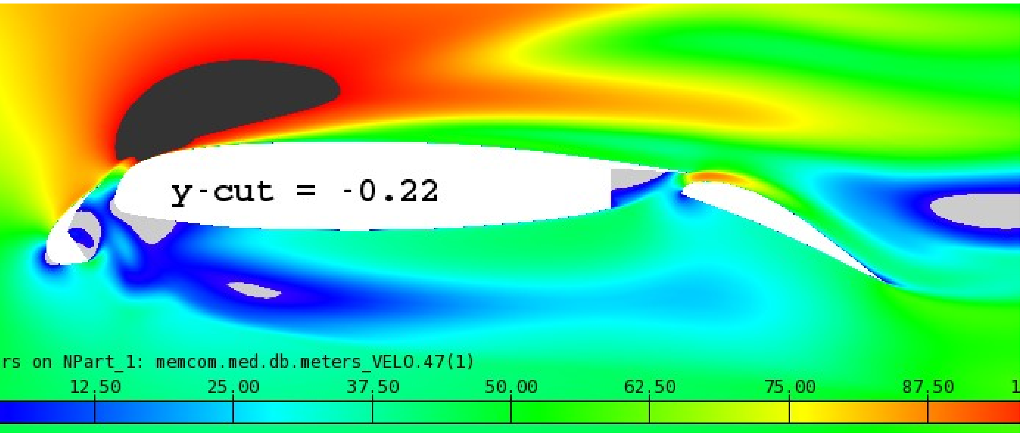
k-w MSS

Spalart

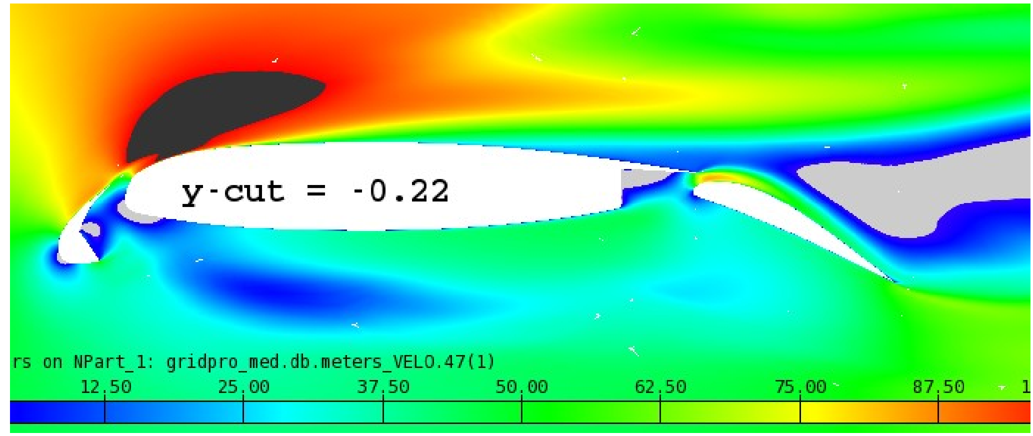




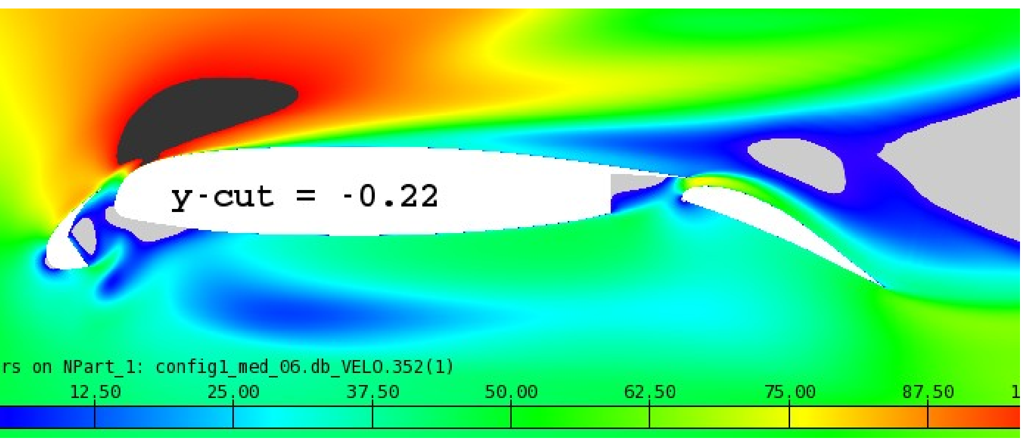
Results – α=28 Different grids - U-velocity



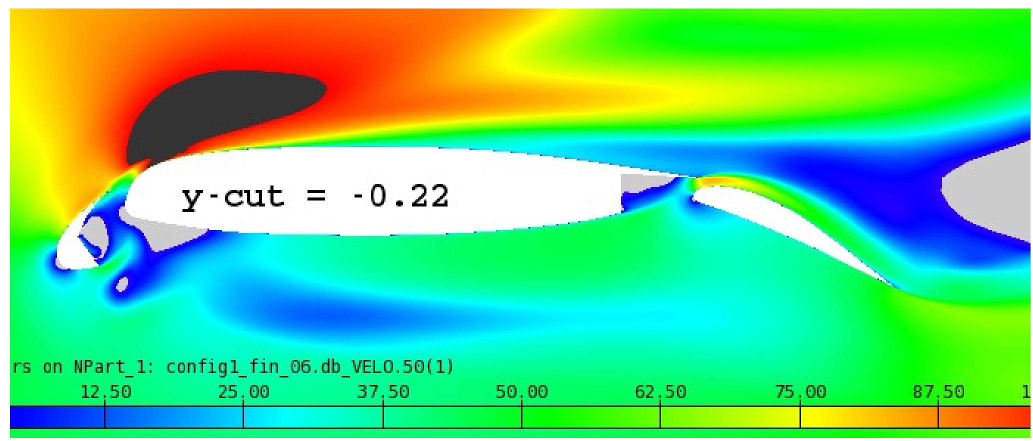
gridA med



gridC med

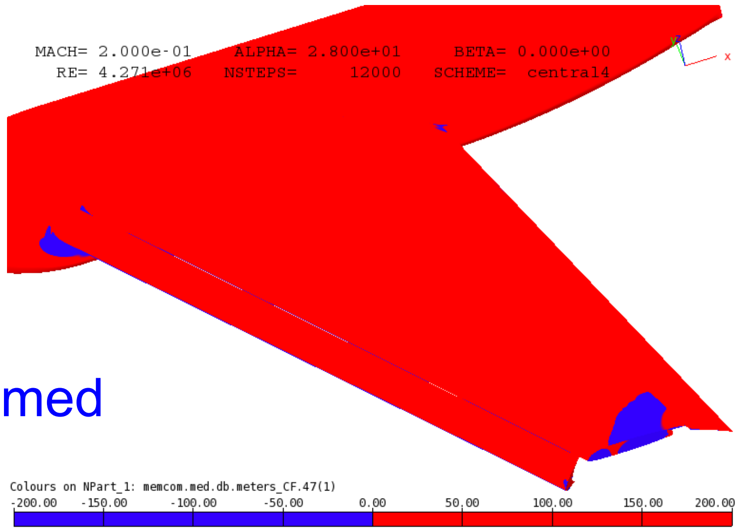


cfse-ra grid med

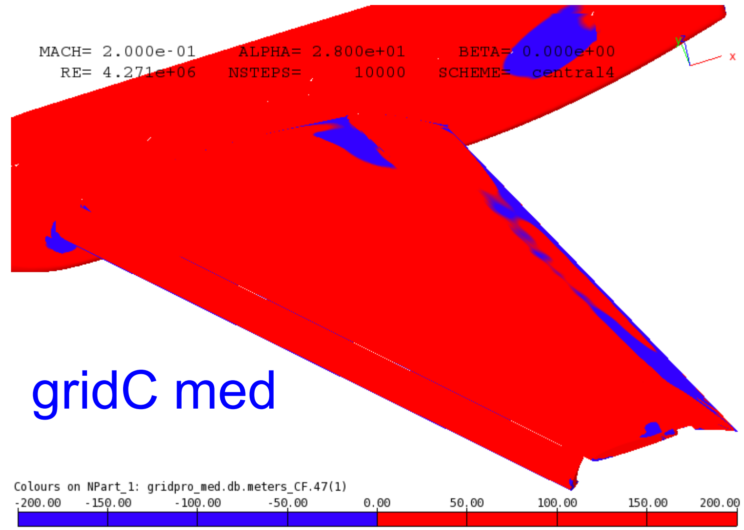


cfse-ra grid fine

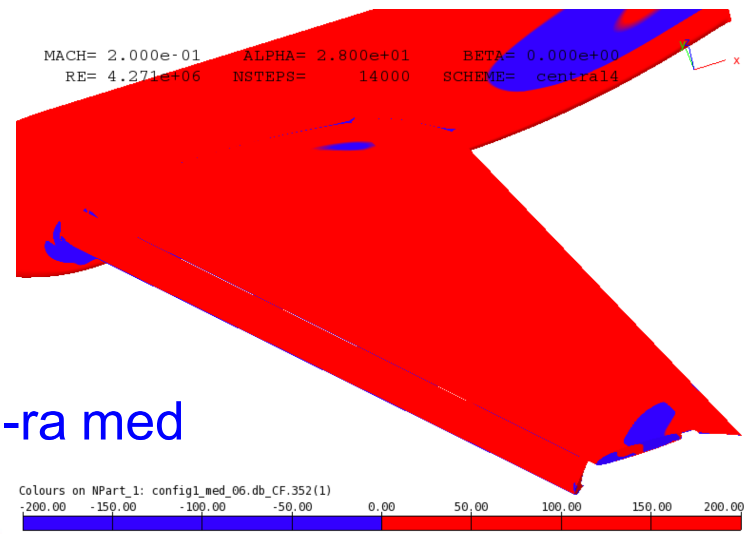
Results – α=28 Different grids - CFx



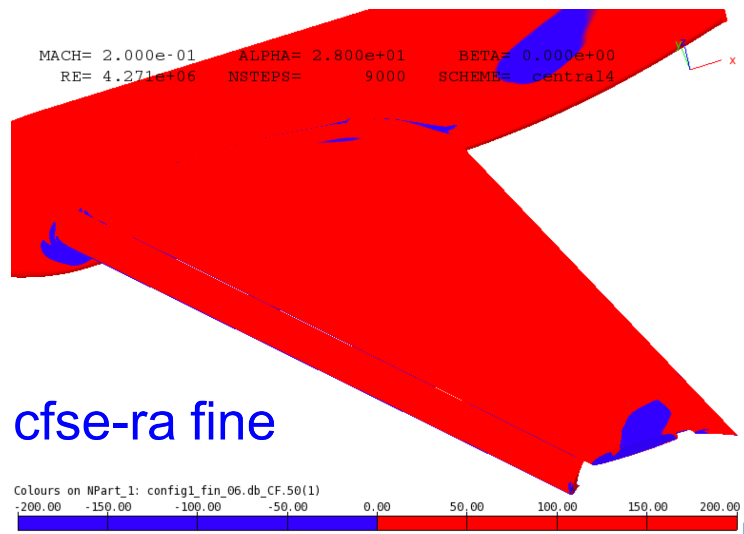
gridA med



gridC med



cfse-ra med



cfse-ra fine

Conclusions

CFD calculations for the high lift configurations were made

The computed results depend on

1. The grid used
2. The turbulence modeling approach

We still do not understand why our medium grid seems to give less good results than the coarse grid for α=28

Questions?

Thank you for your attention.